The impact of adjunctive iliac stenting on femoral-femoral bypass in contemporary practice

Chetan P. Huded, MD,[a] **Philip P. Goodney, MD,**[b,c] **Richard J. Powell, MD,**[b] **Brian W. Nolan, MD,**[b,c] **Eva M. Rzucidlo, MD,**[b] **Samuel T. Simone, MD,**[b] **Daniel B. Walsh, MD,**[b] and **David H. Stone, MD,**[b]
Hanover and Lebanon, NH

Objectives: **Most reports of femoral-femoral bypass (FFB) were published before the era of endovascular intervention. This study examines the utilization and impact of adjunctive endovascular intervention on FFB in contemporary practice.**
Methods: **We reviewed 253 FFB performed in 247 patients between 1984 and 2010. Primary endpoints, including graft patency, primary-assisted patency, limb salvage, and survival, were assessed using Kaplan-Meier life-table analysis. Univariate and multivariate analyses were performed to determine predictors of primary endpoints.**
Results: **The indication for FFB included claudication (27%; n = 69) and critical limb ischemia (72%; n = 184). Forty-eight patients (19%) were treated urgently for acute ischemia. Mean follow-up was 5.6 ± 5.5 years. Over the study interval, adjunctive iliac percutaneous transluminal angioplasty (PTA)/stent placement increased significantly from 0% to 54% (*P* trend < .001), while the rate of axillofemoral bypass or no inflow procedure decreased from 100% to 46% (*P* trend < .001). Despite increased utilization, iliac PTA/stenting was associated with decreased 5-year primary graft patency of 44% compared with 74% for axillofemoral bypass patients and 71% in patients with no adjunctive inflow procedure (*P* = .004). Patients with inflow iliac PTA/stents also had diminished 5-year assisted primary patency of 61% compared with 85% for axillofemoral bypass patients and 87% in patients without inflow revascularization (*P* = .002). Adjunctive iliac PTA/stenting did not impact limb salvage or overall survival. Five-year primary patency among claudicants and critical leg ischemia patients was 65% and 68%, respectively.**
Conclusions: **The incidence of iliac PTA/stent placement in conjunction with FFB has increased significantly over time in contemporary practice. Reliance on iliac stent placement for FFB inflow is paradoxically associated with both diminished primary and assisted primary graft patency when compared with historical controls. These findings highlight the importance of patient selection and inflow consideration when performing FFB. (J Vasc Surg 2012;55:739-45.)**

Femoral-femoral bypass (FFB) remains a commonly performed extra-anatomic revascularization option among patients with multiple comorbidities and significant aortoiliac occlusive disease. Historically, FFB has been reliably used for a myriad of indications, including critical limb ischemia and severe lifestyle-limiting claudication in the setting of unilateral inflow occlusive disease.[1-9] More recently, FFB has also been successfully incorporated into surgical treatment paradigms for aortouniliac reconstructions in the setting of aneurysm disease.[10] Historically, aortobifemoral bypass (AFB) has served as the "gold standard" for aortoiliac revascularization, providing well-documented patency and durability.[2] Despite these results, operative magnitude has often precluded direct anatomic revascularization among frail patients with multiple comorbidities. Accordingly, this subset of patients has previously undergone extra-anatomic revascularization, including FFB performed either alone or as part of an axillobifemoral bypass strategy.

Previously, FFB was performed most commonly among medically high-risk patients unsuited for in-line anatomic reconstruction.[11] Early reports identified significant donor iliac stenosis as a risk factor for subsequent FFB failure.[12,13] The advent of percutaneous endovascular therapies has expanded the applicability of FFB to frail patients with concomitant inflow iliac disease with the potential to treat such lesions with endovascular therapy at the time of bypass.[14-17] Consequently, this has led to a potential paradigm shift in the operative management of such patients. Accordingly, historical series on FFB are unlikely to accurately depict contemporary "real-world" outcomes reflecting adjunctive endovascular intervention at the time of FFB. The purpose of this study is to review trends and outcomes in FFB utilization in the context of concomitant adjunctive inflow procedures performed at the time of surgery. In reviewing a large contemporary cohort of FFB patients, we hope to define whether adjunctive inflow procedures performed at the time of FFB effect primary graft patency, primary-assisted patency, limb salvage, or overall survival.

METHODS

Subjects and database. Clinical, operative, and demographic variables were collected retrospectively on 253

From Dartmouth Medical School, Hanover[a]; the Section of Vascular Surgery, the Dartmouth-Hitchcock Medical Center, Lebanon[b]; and the Dartmouth Institute for Health Policy and Clinical Practice, Center for Leadership and Improvement, Lebanon.[c]
Competition of interest: none.
Presented at the Thirty-sixth Annual Spring Meeting of the Peripheral Vascular Surgery Society, Chicago, Ill, June 15, 2011.
Reprint requests: David H. Stone, MD, Section of Vascular Surgery, Dartmouth-Hitchcock Medical Center, 1 Medical Center Dr, Lebanon, NH 03756 (e-mail: david.h.stone@hitchcock.org).
The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a competition of interest.
0741-5214/$36.00

doi:10.1016/j.jvs.2011.10.036

Table I. Characteristics of the study cohort overall and stratified by inflow revascularization groups

Characteristic	*Overall (n = 253)*	*Non-stented (n = 125)*	*Axillofemoral (n = 87)*	*Stent (n = 43)*	P *value*
Male	143 (56%)	80 (65%)	42 (48%)	21 (49%)	.029
Age, years (range)	68 (39-96)	68 (40-96)	68 (39-86)	68 (43-93)	.970
Diabetes	49 (20%)	24 (20%)	19 (22%)	6 (14%)	.525
Hypertension	142 (58%)	64 (54%)	46 (54%)	32 (74%)	.051
Coronary artery disease	118 (48%)	57 (48%)	48 (56%)	13 (30%)	.019
Congestive heart failure	40 (16%)	18 (15%)	21 (25%)	1 (2%)	.005
Chronic obstructive pulmonary disease	74 (30%)	32 (27%)	28 (33%)	14 (33%)	.622
Creatinine >1.8	22 (9%)	6 (5%)	11 (13%)	5 (12%)	.122
Antiplatelet	64 (39%)	35 (45%)	16 (33%)	13 (33%)	.236
Statin	13 (8%)	3 (4%)	6 (12%)	4 (10%)	.198
Antiplatelet and statin	35 (21%)	11 (14%)	14 (29%)	10 (25%)	.125
Neither antiplatelet nor statin	54 (33%)	28 (36%)	13 (27%)	13 (33%)	.517
Claudication	69 (27%)	44 (36%)	7 (8%)	18 (42%)	<.001
Critical ischemia	184 (73%)	79 (64%)	80 (92%)	25 (58%)	<.001
Acute ischemia	48 (19%)	26 (21%)	18 (21%)	4 (9%)	.206
Profunda outflow	78 (31%)	41 (33%)	12 (29%)	13 (30%)	.671

FFB performed on 247 patients between December 1984 and May 2010. Patients were treated by 12 surgeons at a single academic medical center. All FFB performed during the study interval were identified. FFB performed in the context of an aortouniliac aneurysm repair were excluded from this study. Adjunctive inflow procedures, including axillofemoral bypass and iliac stenting, were performed at the discretion of the attending surgeon at the time of the FFB or within the preceding 1 day.

Outcomes and variable definitions. The endpoints of this study were primary graft patency, assisted primary patency, limb salvage, and survival. Primary and assisted primary patency were assessed in the entire study cohort (n = 253). Failure of primary patency was defined as graft excision, graft revision, or graft thrombosis confirmed by duplex ultrasonography, angiography, or ankle-brachial indexes. Failure of assisted primary patency was defined as any intervention or reoperation to maintain graft patency following FFB. Limb salvage and survival were assessed in patients with critical limb ischemia (n = 184) defined as acute-onset ischemia, rest pain, or tissue loss. Failure of limb salvage was defined as any major amputation of either lower extremity. Survival was assessed by review of the medical record and the social security death database.

Statistical analysis. Comparisons among groups were tested with the χ^2 test and one-way analysis of variance. Univariate analysis was performed using the χ^2 test to identify potentially relevant variables predictive of the main outcome measures. Variables with a significant association at $P < .10$ were used to construct a multivariate model using backwards stepwise logistic regression. Hazard ratios (HRs) and 95% confidence intervals (CIs) were generated for significant endpoint predictors using Cox proportional hazards modeling, with $P < .05$ considered significant. Trends in inflow revascularization over time were analyzed by dividing the study interval into 3-year subintervals and applying a nonparametric test of trend. This study was conducted in compliance with the Institutional Review Board at Dartmouth Medical School.

RESULTS

Over the study period, 253 FFB were performed in 247 patients. Among the bypasses performed, 27% (n = 69) were for lifestyle-limiting claudication, while 73% (n = 184) were for critical limb ischemia, including 19% (n = 48) that were performed emergently for acute ischemia. The use of adjunctive inflow procedures varied among the study population. Inflow axillofemoral bypass was performed in 34% (n = 84), while inflow iliac stenting was performed in 16% (n = 43). Two patients underwent inflow percutaneous transluminal angioplasty (PTA) alone without stenting and were included in the concomitant intervention group. Nearly half of the study population, 49% (n = 125), underwent neither inflow PTA/iliac stenting nor axillofemoral bypass at the time of reconstruction.

Demographics and comorbidities were typical for this patient population, with a significant incidence of hypertension, coronary artery disease, congestive heart failure, and diabetes. Nearly one-third of the patients had a history of chronic obstructive pulmonary disease. Patient demographics and comorbidities varied among the three groups. Cardiac comorbidities were significantly more common in patients undergoing adjunctive axillofemoral bypass and less common in patients undergoing adjunctive iliac stenting. Patients undergoing axillofemoral bypass were also significantly more likely to suffer from critical limb ischemia rather than claudication. Fifty-two patients (21%) underwent prior inflow revascularization before ultimately undergoing FFB. Of note, there was no significant difference in profunda outflow patency status among the groups (Table I).

Trends in adjunctive inflow revascularization over time were evaluated, stratifying the study period into 3-year intervals. Comparison of the first 3-year interval to the most recent interval demonstrated a decrease in the rate of inflow axillofemoral bypass grafting from 33% to 19%. Similarly, the incidence of patients undergoing no concomitant adjunctive inflow procedure decreased

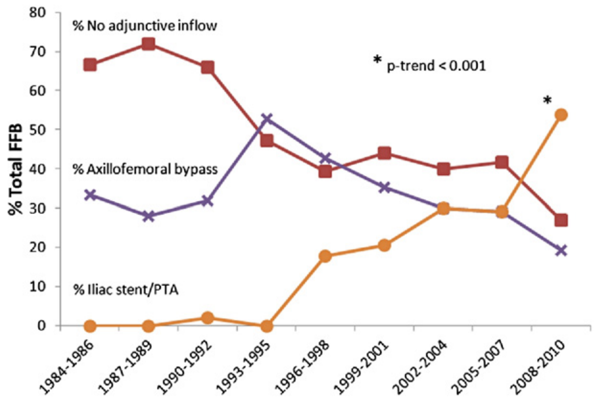

Fig 1. Inflow revascularization trends over the study interval. *PTA*, Percutaneous transluminal angioplasty.

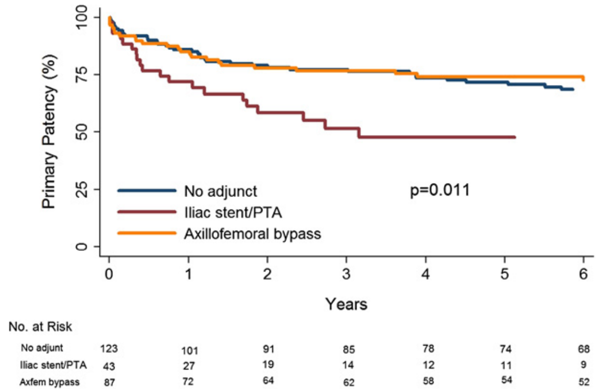

Fig 2. Primary patency stratified by adjunctive inflow revascularization. *PTA*, Percutaneous transluminal angioplasty.

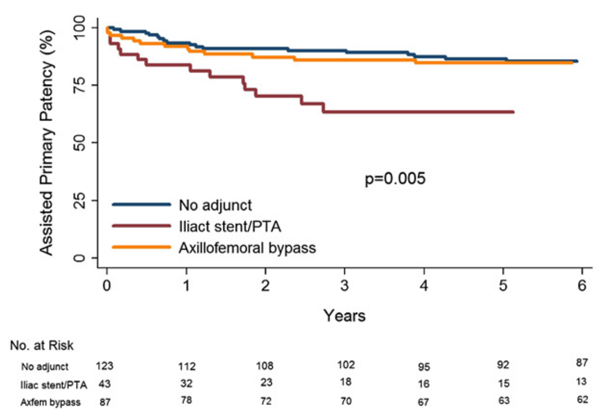

Fig 3. Assisted primary patency stratified by adjunctive inflow revascularization. *PTA*, Percutaneous transluminal angioplasty.

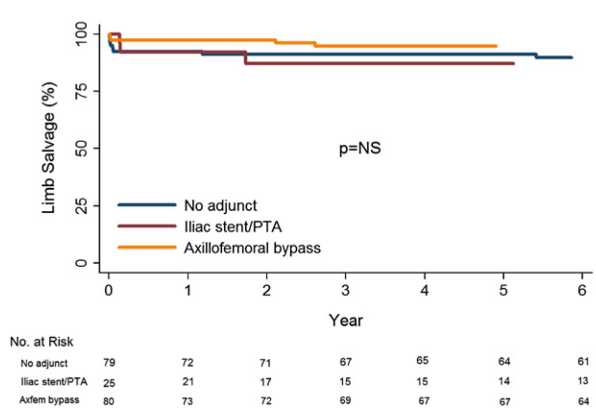

Fig 4. Limb salvage stratified by adjunctive inflow revascularization. *PTA,* Percutaneous transluminal angioplasty.

from 67% to 27% over the same interval. In total, the rate of patients who underwent either axillofemoral bypass or no adjunctive inflow revascularization decreased from 100% to 46% (P trend $<$ .001). Conversely, the rate of inflow iliac stenting increased from 0% to 54% over the study interval (P trend $<$ .001; Fig 1).

Overall 5-year primary patency was 68%, and assisted primary patency was 82%. There was no significant difference in patency after stratifying the cohort by surgical indication. Primary patency was 66% among claudicants and 69% among patients with critical limb ischemia (P = not significant [NS]). Similarly, assisted primary patency was 82% among both claudicants and patients with critical limb ischemia (P = NS). Limb salvage rate at 5 years was 91%, whereas overall 5-year survival was 43% among patients with critical limb ischemia.

Univariate analysis demonstrated that adjunctive inflow iliac PTA/stenting was associated with diminished primary graft patency. Five-year primary patency in patients undergoing iliac PTA/stenting was 44%, compared with 74% for patients undergoing axillofemoral bypass and 71% for patients who did not undergo adjunctive inflow revascularization (P = .004; Fig 2). Additionally, assisted primary patency was diminished in patients who underwent adjunctive inflow iliac PTA/stenting. Five-year assisted primary patency was 61% among adjunct iliac PTA/stent patients, compared with 85% among concomitant axillofemoral bypass, and 87% among those without adjunctive inflow revascularization (P = .002; Fig 3). Limb salvage rates and overall survival did not differ among patients with limb-threatening ischemia when stratified by adjunctive inflow revascularization (Figs 4 and 5).

Multivariate logistic regression was used to control for other variables, including medical comorbidities, adjunctive medication use, remote antecedent revascularization, and postoperative complications. Inflow iliac stenting was identified as an independent predictor of both diminished primary patency (HR, 2.37; CI, 1.2-4.9; P = .019) and diminished assisted primary patency (HR, 2.51; CI, 1.2-5.2; P = .013). Graft infection and previous inguinal revascularization of the symptomatic limb were also identified as independent predictors of both diminished primary and assisted primary patency (Tables II and III).

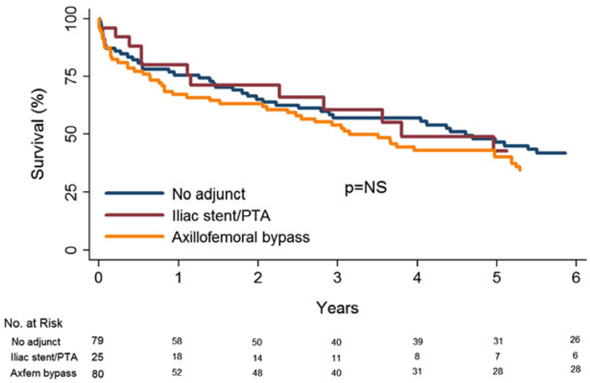

Fig 5. Survival stratified by adjunctive inflow revascularization. *PTA*, Percutaneous transluminal angioplasty.

Table II. Significant independent predictors associated with primary patency

	Hazard ratio	*95% Confidence interval for hazard ratio*		*P value*
		Lower	*Upper*	
Prior inflow procedure	2.70	1.31	5.58	.007
Graft infection	3.12	1.09	8.98	.035
Inflow stent	1.09	0.97	4.04	.06

Table III. Significant independent predictors associated with primary assisted patency

	Hazard ratio	*95% Confidence interval for hazard ratio*		*P value*
		Lower	*Upper*	
Prior inflow procedure	2.02	1.08	3.77	.028
Graft infection	3.92	1.44	10.68	.008
Inflow stent	2.31	1.12	4.75	.023

DISCUSSION

This study is among the first to demonstrate that the use of adjunctive endovascular iliac PTA/stenting, performed in conjunction with FFB, has significantly increased in contemporary surgical practice. Paradoxically, these endovascular interventions appear to be associated with both diminished primary and assisted primary graft patency. In fact, over half of all FFB procedures in recent years were performed in conjunction with concomitant iliac stent placement. These findings document a potentially significant shift in the utilization of adjunctive inflow procedures performed in conjunction with FFB. Given the pervasive need for adjunctive inflow revascularization at the time of FFB, these findings should have important implications when considering vascular reconstruction among such typically debilitated patients, and more importantly, may have implications on midterm graft performance.

Historically, AFB has been the "gold standard" inline anatomic vascular reconstruction for patients with unilateral or bilateral significant aortoiliac occlusive disease.[2] Despite promising results, the impact of a large transabdominal operation and ensuing postoperative course has rendered it unsuited for a growing subset of frail patients with multiple comorbidities. Accordingly, FFB, either alone or performed as part of an axillobifemoral extra-anatomic reconstruction, has been well suited for such clinical circumstances. Although long-term results have not equaled AFB, FFB has been shown to provide satisfactory patency and limb salvage among such high-risk patients with limited life expectancy.[4] The advent of endovascular therapies for the treatment of arterial occlusive disease has expanded the anatomic profile of patients deemed suitable to undergo FFB. Consequently, patients with donor inflow disease are anatomically eligible for concomitant endovascular intervention at the time of surgery, obviating the need for a more extensive extra-anatomic revascularization such as axillobifemoral bypass. Despite this evolution in practice, reports of outcomes for FFB performed in conjunction with ipsilateral percutaneous intervention remain somewhat limited.

Prior reports have demonstrated mixed results using donor iliac intervention in conjunction with FFB for patients with bilateral aortoiliac occlusive disease. Lopez-Galarza et al documented associated 5-year primary patency to be 51% in a review of 18 patients who underwent FFB with adjunctive iliac stenting in the setting of a stenosis shorter than 3 cm.[15] However, these conclusions remain limited, given the study's small sample size and lack of comparison to a nonstented group. Perler et al reported a satisfactory 5-year patency of 79% among 26 patients who underwent iliac angioplasty or stenting at the time of FFB. Interestingly, the study also demonstrated a 5-year patency of 59% among patients who did not undergo endovascular intervention, although this was not significantly different.[18] In another study, AbuRahma et al reported a series of 41 patients undergoing FFB, in which 92% underwent iliac stenting in the setting of iliac lesions >5 cm in length as compared with 14% who underwent associated stenting in the setting of a lesion <5 cm in length. Perhaps not surprisingly, 3-year primary patency was 31% in patients with longer segment stenoses versus 85% in those with shorter lesions.[19] Indeed, these results highlight both the variation in utilization of concomitant iliac stenting performed at the time of FFB and the durability of such interventions performed at the time of extra-anatomic bypass.

By comparison, this study helps to clarify both the growing incidence and outcomes of adjunctive endovascular inflow revascularization performed at the time of FFB. Most importantly, this study demonstrates a significant increase in the rate of adjunctive iliac stenting over time from 0% to 54%. Over the same interval, the incidence of axillobifemoral reconstruction or no concomitant inflow procedure has decreased from 100% to 46%. This paradigm shift likely reflects the obvious appeal and less invasive alternative of inflow stenting compared with axillobifemoral bypass. However, this study also documents diminished 5-year primary patency (44%) and assisted primary patency (61%) associated with adjunctive iliac stenting. By comparison, axillofemoral inflow revascularization demonstrated 5-year primary patency of 74%, similar to those patients who did not require any adjunctive inflow revascularization (71%). Conceivably, these results suggest the possibility that residual iliac disease can remain untreated, perhaps unknowingly, at the time of FFB, especially when performed under more urgent or emergent conditions. Rzucidlo and colleagues have previously demonstrated that durable iliac stenting is predicated on thorough anatomic stenting and assessment for persistent pressure gradients, necessitating the need for thorough interrogation at the time of FFB.[20] Accordingly, these findings would suggest that routine pressure gradients should be obtained to exclude the possibility for unappreciated occlusive disease at the time of surgery.

While adjunctive iliac PTA/stenting was associated with diminished primary and assisted primary patency, 5-year limb salvage rates appeared unaffected by adjunctive concomitant inflow revascularization. These findings appear similar to several historical reports. Schneider et al documented a 3-year limb salvage rate of 88% among patients undergoing FFB, whereas Mingoli et al demonstrated a 5-year limb salvage rate of 78% following FFB.[2,3] Interestingly, this study demonstrated that limb salvage rates remained largely unaffected by associated inflow revascularization performed in conjunction with FFB (5-year limb salvage rates: iliac PTA/stent 87%, axillofemoral bypass 91%, no concomitant inflow procedure 91%, respectively; P = NS). Additional reports documenting associated limb salvage rates stratified by inflow revascularization remain scarce. The aforementioned study by AbuRahma et al demonstrated no significant difference in limb salvage among patients with long-segment (>5 cm) and short-segment (<5 cm) donor iliac stenosis.[19] Preserved rates of limb salvage likely reflect the complex and multifactorial etiologies leading to major amputation. The presence of multilevel occlusive disease would clearly impact ongoing lower extremity arterial insufficiency irrespective of FFB patency and accordingly account for this finding.

Overall 5-year survival following FFB was 43%, concordant with other previously published series.[3,6] Diminished survival appears to be refractory in this patient population despite the evolution in FFB therapy toward a combined bypass and endovascular treatment posture. This may indeed reflect the pervasive high comorbidity profile these patients share with associated high rates of coronary artery disease (48%; n = 118) and congestive heart failure (16%; n = 40), among others. Therefore, it is not surprising that inflow revascularization in conjunction with FFB has not had a significant impact on mortality.

This study has several intrinsic limitations. First, it remains a single-center retrospective study. Nevertheless, it does reflect the treatment utilization and overall results in a "real-world" academic medical center practice. Furthermore, adjunctive procedures were determined by the operating attending surgeon, and thus we remain limited in our ability to discern differences at the surgeon level in choosing various adjunctive procedures over the extended study interval. Additionally, details surrounding the anatomic disease burden/TransAtlantic Inter-Society Consensus (TASC) classification of the patients undergoing therapy remain limited. Although axillofemoral bypass would intuitively be more prevalent among patients with more advanced occlusive disease profiles, this study has clearly demonstrated decreased utilization of this procedure over time. Moreover, TASC classification changed over the study interval, further confounding any ability to classify disease severity at the time of surgery. Additionally, since only two patients underwent PTA alone, we remain more limited in our conclusions of this small subset of patients. Accordingly, it remains unclear whether these patients had sufficiently mild inflow aortoiliac occlusive disease to obviate concomitant stent placement, in whom FFB patency was not diminished, or whether the necessity of adjunctive inflow angioplasty at the time of surgery rather reflected a hemodynamically significant donor iliac stenosis, which may contribute to diminished long-term patency. Nevertheless, these results do reflect "real-world" practice over time in a busy academic medical center practice.

CONCLUSIONS

This series of 253 FFB spanning the current era of endovascular intervention demonstrates an increase in the incidence of adjunctive iliac stenting at the time of FFB. Despite this evolving trend, inflow iliac PTA/stenting combined with FFB does not ensure durable graft patency in this presumptive high-risk patient population. These findings highlight the importance of careful inflow consideration at the time of FFB, and its role as a significant contributor to overall FFB performance.

AUTHOR CONTRIBUTIONS

Conception and design: DS
Analysis and interpretation: CH, PG, RP, BN, ER, SS, DW, DS
Data collection: CH, SS DS
Writing the article: CH, PG, DS
Critical revision of the article: PG, RP, ER, JC, DW, DS
Final approval of the article: CH, PG, RP, BN, ER, SS, DW, DS
Statistical analysis: CH, PG, BN
Obtained funding: N/A
Overall responsibility: DS

REFERENCES

1. Self SB, Richardson JD, Klamer TW, Kaebnick HW, Lambert GE, Mitchell RA. Utility of femorofemoral bypass. Comparison of results with indications for operation. Am Surg 1991;57:602-6.
2. Schneider JR, Besso SR, Walsh DB, Zwolak RM, Cronenwett JL. Femorofemoral versus aortobifemoral bypass: outcome and hemodynamic results. J Vasc Surg 1994;19:43-55; Discussion 55-7.
3. Mingoli A, Sapienza P, Feldhaus RJ, Di Marzo L, Burchi C, Cavallaro A. Comparison of femorofemoral and aortofemoral bypass for aortoiliac occlusive disease. J Cardiovasc Surg (Torino) 2001;42:381-7.
4. Deruyter L, Caes F, Van den Brande P, Cham B, Welch W. Femorofemoral bypass grafting in high-risk patients. Acta Chir Belg 1986;86:271-6.
5. Criado E, Farber MA. Femorofemoral bypass: appropriate application based on factors affecting outcome. Semin Vasc Surg 1997;10:34-41.
6. Mii S, Eguchi D, Takenaka T, Maehara S, Tomisaki S, Sakata H. Role of femorofemoral crossover bypass grafting for unilateral iliac atherosclerotic disease: a comparative evaluation with anatomic bypass. Surg Today 2005;35:453-8.
7. Capoccia L, Riambau V, da Rocha M. Is femorofemoral crossover bypass an option in claudication? Ann Vasc Surg 2010;24:828-32.
8. Berce M, Sayers RD, Miller JH. Femorofemoral crossover grafts for claudication: a safe and reliable procedure. Eur J Vasc Endovasc Surg 1996;12:437-41.
9. Buchbinder D, Pasch AR, Schuler JJ, Meyer JP, Dillon BC, Rollins DL, et al. Efficacy of femorofemoral bypass for intermittent claudication. Clinical and hemodynamic assessment. Am J Surg 1986;152:215-9.
10. Hinchliffe RJ, Alric P, Wenham PW, Hopkinson BR. Durability of femorofemoral bypass grafting after aortouniiliac endovascular aneurysm repair. J Vasc Surg 2003;38:498-503.
11. Plecha FR, Plecha FM. Femorofemoral bypass grafts: ten-year experience. J Vasc Surg 1984;1:555-61.
12. Flanigan DP, Pratt DG, Goodreau JJ, Burnham SJ, Yao JS, Bergan JJ. Hemodynamic and angiographic guidelines in selection of patients for femorofemoral bypass. Arch Surg 1978;113:1257-62.
13. Subram AN, Urrutia-S CO, Ott DA, Cooley DA. Femorofemoral bypass: prognostic factors. Tex Heart Inst J 1983;10:257-61.
14. Howell HS, Ingram CH, Parham AR, Miller IB, Harriss WF, Wood JL, et al. Transluminal angioplasty of the iliac artery combined with femorofemoral bypass. South Med J 1983;76:49-51.
15. Lopez-Galarza LA, Ray LI, Rodriguez-Lopez J, Diethrich EB. Combined percutaneous transluminal angioplasty, iliac stent deployment, and femorofemoral bypass for bilateral aortoiliac occlusive disease. J Am Coll Surg 1997;184:249-58.
16. Shah RM, Peer RM, Upson JF, Ricotta JJ. Donor iliac angioplasty and crossover femorofemoral bypass. Am J Surg 1992;164:295-8.
17. Ohki T, Marin ML, Veith FJ, Lyon RT, Sanchez LA, Suggs WD, et al. Endovascular aortounifemoral grafts and femorofemoral bypass for bilateral limb-threatening ischemia. J Vasc Surg 1996;24:984-96; discussion 996-7.
18. Perler BA, Williams GM. Does donor iliac artery percutaneous transluminal angioplasty or stent placement influence the results of femorofemoral bypass? Analysis of 70 consecutive cases with long-term follow-up. J Vasc Surg 1996;24:363-9; discussion 369-70.
19. Aburahma AF, Robinson PA, Cook CC, Hopkins ES. Selecting patients for combined femorofemoral bypass grafting and iliac balloon angioplasty and stenting for bilateral iliac disease. J Vasc Surg 2001;33:S93-9.
20. Chang RW, Goodney PP, Baek JH, Nolan BW, Rzucidlo EM, Powell RJ. Long-term results of combined common femoral endarterectomy and iliac stenting/stent grafting for occlusive disease. J Vasc Surg 2008;48:362-7.

Submitted Aug 9, 2011; accepted Oct 13, 2011.

DISCUSSION

Dr Kelley Hodgkiss-Harlow (*Tampa, Fla*). I would like to congratulate Dr. Huded and colleagues for a very well-written paper. Thank you for providing it to me well in advance of the meeting.

After reading your paper, which examined the utilization and impact of adjunctive endovascular intervention for femoral-femoral bypass, I have several questions. First, given that you mention several times that the gold standard for inflow disease in the setting of leg ischemia is aortobifemoral bypass, did you include any cohort of patients who underwent either aortobifemoral, aortoiliac, or iliofemoral bypass in your surgical results to compare patency?

Second, as you mentioned, other papers have compared patency of iliac stenting in the setting of TASC classification of the lesions stented. Do you have any information on those patients in your cohort in terms of TASC classification of their iliac lesions?

Third, what was the mechanism of failure in your iliac stent group (ie, did procedures fail secondary to iliac stent failure or occlusion, or were they more related to femoral-femoral bypass issues or outflow issues)?

Lastly, since your group advocates a thorough investigation of the iliac arteries prior to proceeding with femoral-femoral bypass, were you able to see if this was performed in your cohort either through angiographic or pressure measurements or computed tomography imaging?

Dr Chetan P. Huded. Thank you, Dr. Hodgkiss-Harlow, for your commentary. In regards to your first question about comparison to direct anatomic bypass, such as aortobifemoral bypass, we did not include a group of patients who underwent aortobifemoral bypass or other direct anatomic bypass. We would submit that the superior patency afforded by aortobifemoral bypass is well documented in historical reports, and we sought to examine a different group of patients in whom presumably aortobifemoral bypass would not be a suitable procedure.

In regards to your second question about TASC classification, we did not include anatomic information about donor iliac lesions in our patient cohort. We would agree that anatomic characteristics of the donor iliac artery could affect outcomes in our cohort, and it would certainly be an interesting variable to investigate. Unfortunately, our data is limited in that regard. Moreover, the decision to treat donor iliac occlusive disease was determined by the discretion of the attending surgeon at the time of surgery, and we remain limited in our ability to discern differences at the surgeon level.

In regards to your third question about mechanism of failure in our iliac stent group, we believe that the mechanism of failure in these patients is likely multifactorial. Conceivably, it could represent residual untreated inflow iliac occlusive disease despite iliac stent placement. Additionally, regarding the question of outflow, we found no significant difference among the three groups that would explain diminished patency in the iliac stent group. However, a specific mechanism of failure for each patient was not recorded, so failure in the iliac stent group cannot be definitively attributed to any specific mechanism.

In regards to your fourth question about investigation of inflow status at the time of fem-fem bypass, we remain limited in our ability to draw conclusions about inflow investigation, given that the use of pressure gradients or other mechanisms of inflow investigation was left to the discretion of the attending surgeon at the time of surgery, and there was no standardized utilization of any of the mechanisms you discussed. These would certainly be interesting interventions to investigate in the future.

Dr Ravi Veeraswamy (*Atlanta, Ga*). I guess I'm looking for some guidance here. Would you or your group advocate that I not put iliac stents in before fem-fem bypasses? What is the take-home message here? It's hard for me to understand how you're getting better patency with an ax-fem than with an iliac stent/fem-fem. When we walk out of this room, how should we change our practice based on these data?

Dr Huded. Thank you for your question. We certainly would not suggest that iliac stenting at the time of fem-fem bypass is inherently at fault for diminished patency rates in these patients. Our study supports the conclusion that thorough investigation of donor iliac occlusive disease at the time of fem-fem bypass when performed in conjunction with endovascular intervention is critical. Ensuring that donor iliac occlusive disease is adequately treated prior to placement of a fem-fem bypass is the strongest clinical conclusion that can be drawn from our data.